DOCUMENT RESUME

ED 120 691 CS 002 522

AUTHOR Dunn-Rankin, Peter
TITLE Using After Images in the Analysis of Letter and Word Focalization.
PUB DATE Apr 76
NOTE 23p.; Paper presented at the Annual Meeting of the American Educational Research Association (San Francisco, California, April 19-23, 1976); Not available in hard copy due to marginal legibility of original document

EDRS PRICE MF-$0.83 Plus Postage. HC Not Available from EDRS.
DESCRIPTORS *Eye Fixations; Eye Movements; *Figural Aftereffects; *Letters (Alphabet); Models; Reading; *Reading Processes; Reading Research; Reading Skills; *Visual Perception; Visual Stimuli; Word Recognition

ABSTRACT

This paper presents the results of investigations into mature readers' focal point when viewing letters, words, and phrases. The focal points are accurately determined by using the after image created from a spot of light. The after image is then superimposed on the reading material. The results show that the focal point does not fall haphazardly on the stimulus, nor is it evenly distributed. Rather, a mechanism of subconscious visual preprocessing is suggested. This preprocessing, while an innate capacity of the organism, is susceptible to development by frequency of exposure to such symbolic stimuli as letters and words. In the mature reader this visual preprocessing results in an efficient placement of the focal point. A developmental model of visual preprocessing as it relates to reading is proposed. (JM)

****
* Documents acquired by ERIC include many informal unpublished *
* materials not available from other sources. ERIC makes every effort *
* to obtain the best copy available. Nevertheless, items of marginal *
* reproducibility are often encountered and this affects the quality *
* of the microfiche and hardcopy reproductions ERIC makes available *
* via the ERIC Document Reproduction Service (EDRS). EDRS is not *
* responsible for the quality of the original document. Reproductions *
* supplied by EDRS are the best that can be made from the original. *
****

ED120691

U S DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

SCOPE OF INTEREST NOTICE

The ERIC Facility has assigned this document for processing to: CS FL

In our judgement, this document is also of interest to the clearinghouses noted to the right. Indexing should reflect their special points of view.

Using After Images in the Analysis of Letter and Word Focalization

PETER DUNN-RANKIN
University of Hawaii

"PERMISSION TO REPRODUCE THIS COPYRIGHTED MATERIAL BY MICROFICHE ONLY HAS BEEN GRANTED BY
Peter Dunn-Rankin

TO ERIC AND ORGANIZATIONS OPERATING UNDER AGREEMENTS WITH THE NATIONAL INSTITUTE OF EDUCATION. FURTHER REPRODUCTION OUTSIDE THE ERIC SYSTEM REQUIRES PERMISSION OF THE COPYRIGHT OWNER."

Abstract

This paper presents the results of investigating mature readers' focal points when viewing letters, words, and prhases. The focal points are accurately determined by using the after image created from a spot of light. The after image is then superimposed on the reading material. Several interesting hypotheses are suggested from these experiments which imply subconscious pre-processing for the mature reader.

BEST AVAILABLE COPY

CS 022 522

USING AFTER IMAGES IN THE ANALYSIS OF LETTER AND WORD FOCALIZATION

Peter Dunn-Rankin
University of Hawaii

Introduction

I first noticed the usefulness of the after image as a representation of one's focal point during a camping trip in 1969. A gas lamp was hung in the tent where I was reading and I was drawn to stare at for some reason, perhaps because it wasn't working well. On returning to the printed page the after image of the bright mantel was clearly seen superimposed over the printed material at each fixation point. I immediately began dotting the fixation points as I read.

In 1973, while a fellow at the perception laboratory at the University of Stockholm, I began to systematically study and use this kind of after image as part of the search for effective cues to letter and word identification. At that time I discovered by accident that the apparent size of the after image is a function of the distance at which it is projected. By creating after images from light sources (approximately one centimeter in diameter) at a distance of two or three meters the apparent after image can be made quite small if fixated on a surface held a short distance away (approximate reading distance). The image can, in fact, be made small enough to be accurately pinpointed within common textbook font, i.e., 12 points or less.

General Method

The subject is asked to fixate on a 40 watt screened light projected from a dark, unlighted background through a hole 1 cm. in diameter located at a distance of approximately 3 meters. The subject gazes at the source for about one and a half minutes or until the light appears to "swim" or "shimmer" and a grey after image is produced when looking at a white sheet of paper. As an aid in locating the after image the subject is asked to close or "blink" his eyes. A bright dot or flash of light is universally reported by subjects at the same position as the after image. Stimuli are usually typed letters or drawn black figures on white nonreflective cards or paper.

The projected after image varies between individuals but is usually described as consisting of two types, one following the other. First, a dark grey spot occurs approximately 1-2 mm in diameter which is seen superimposed on white or light grey paper. Wherever the subject glances the center of this grey dot is taken as the focal point. This grey image lasts about 30 seconds but is followed by a pink or red circle from one to two mm in diameter which persists for as long as three minutes. Several positions of the after image are easily remembered by the subject when he looks at graphic material.

A test of the accuracy of each subject's focal point is made by having them fixate on a "cross" drawn in the center of a white sheet of paper and then locating and dotting the after image with a felt tip pen on this cross. If the light source is at eye level and placed directly in front of the subject the focal point should fall at the intersection of the two crossed lines.

Figures 1 and 2 about here.

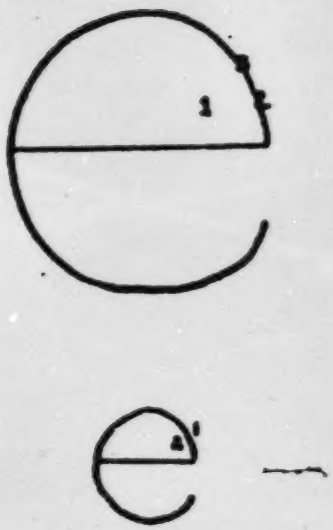


Fig. 1 -- After image focal points for the letter g. Despite differences in size location of the focal point remains relatively constant.

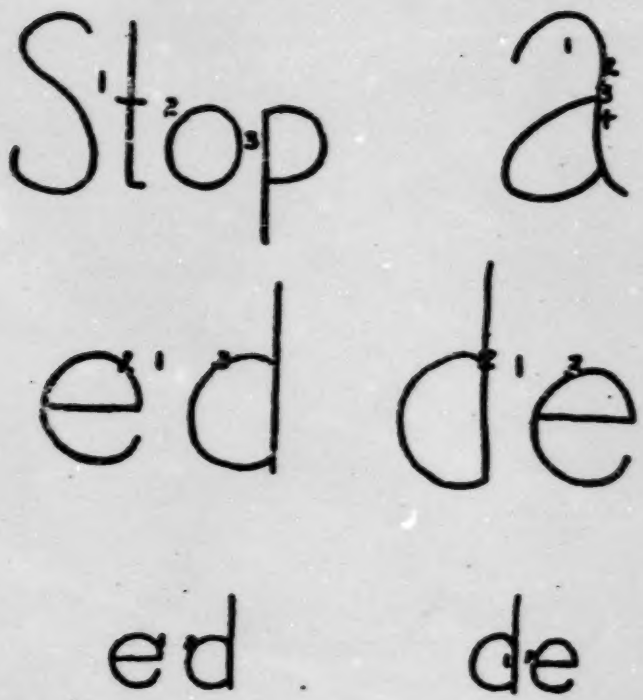


Fig. 2 -- After image focal points for enlarged letter a, the word stop, and letter parts ed and de. Letter pairs are viewed centrally.

Experiments

Letters. Initial subjective experiments were done with large hand drawn letters (see figures 1 and 2). In these studies an attempt was made to isolate the unique features of the letters under the theory supported by Norton and Stark (1971) that large objects made so small as to be covered in one fixation were internally scanned as if they were of their original size. Reversing this idea it was hypothesized that the focal point scanning of enlarged letters and words would reveal the important cues to identification of these generally smaller stimuli. In figures 1 and 2 the position and order of fixation are provided by the sequential numbers. These examples reveal that (1) different large letter stimuli are fixated in different places, (2) most fixations occur to the right and above the centroid of the letters, (3) initial focal point locations appear efficient for identification or confirmation of the letters, and (4) when letters are reduced in size some focal points remain in the same relative positions.

Words. Preliminary studies indicated that as words increased in length the subjects' focal point moved progressively to the right of the initial letter. H. Bouma's (1973) studies show that Danish Ss could see farther to the right of the fixation point than they could to the left. It seemed reasonable to Bouma that in a word like today the focal point should be located just to the right of the o; for example,

o
today

since this would be an efficient place to view the entire word.

Two sets of stimulus material were constructed. One consisted of three groups of words with similar spellings but of different lengths as presented in table 1.

Table 1

Words of Different Length with Similar Beginning Letter

fi	do	me
fin	don	men
fine	done	mean
finer	doing	means
finest	donuts	meaner
finland	dormant	meanest
finished	dormouse	meaningful

The second set consisted of words that sound alike, are of the same length, but are visually different homonyms such as choir--quire and friar--fryer, for example. A set of ten pairs of homonyms were selected and together with the words from table 1 randomly ordered. This new set of words were typed using IBM Prestige Elite type and then mimeographed on 8 1/2 x 11" white paper. (See Appendix A for this set of stimuli).

Five graduate students in Educational Psychology at the University of Hawaii, 3 men and 2 women, located and marked their focal points for each word on two separate occasions.

Figure 3 shows the consolidated results of all the focal points on these two occasions for the words with similar beginnings.

Figure 3 about here.

Figure 4 presents the median focal points connected by a straight line with the words arranged in pyramidal fashion.

Figure 4 about here.

From these results it is clear that as a word gets larger the focal point is more centrally located. The variance of the positions, however, increases markedly with longer words suggesting a greater choice of stimuli that are effective to look at and also indicating that longer words may cause some subjects to adjust their focal point back to the left as a strategy to clearly see the initial letter. In almost all cases one focal point has sufficed for each of these words. The focal points are also characteristically found on the upper border of the lower case letters.

The set of homonyms was used to test a theory of subconscious visual preprocessing and to look at the reliability and individual differences in focal point representation. Ross (1976) has suggested that subconscious visual preprocessing occurs very rapidly in the visual system. Since the focal point does not fall haphazardly but rather is definitely related to word length some peripheral processing must be used in determining its location.

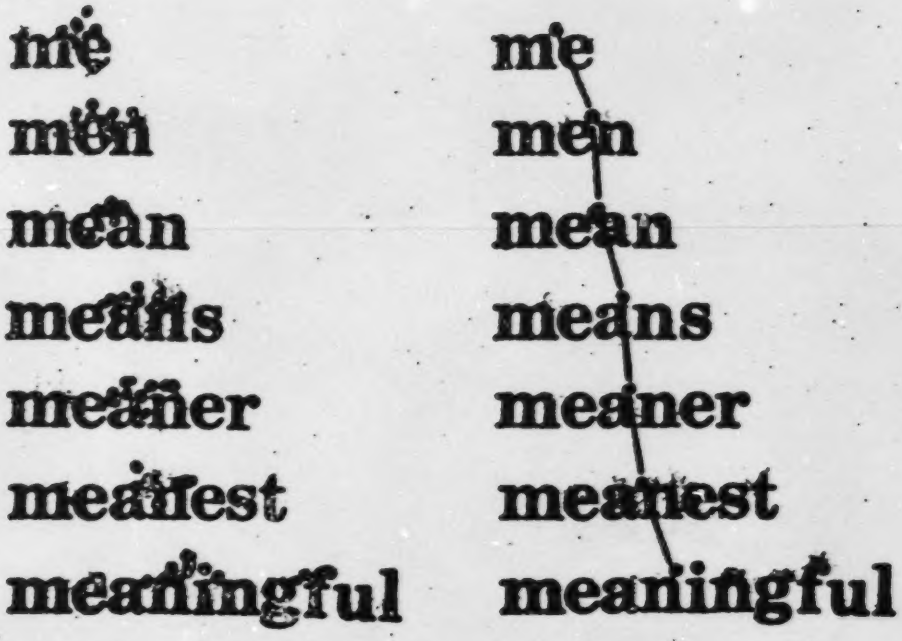
Figure 5 illustrates six pairs of homonyms for each subject.

Figure 5 about here.

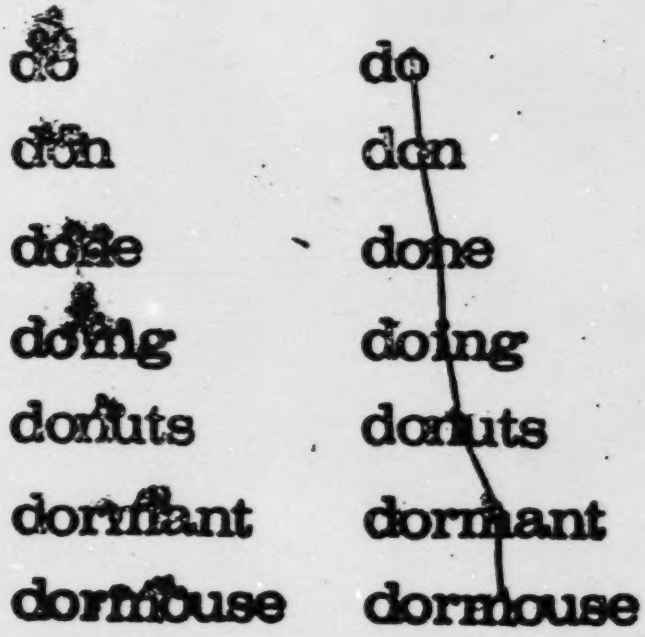
While no quantitative measure has been determined as an index of reliability one has the impression that individual subject responses are very consistent from one report to the next. Differences between individuals appear to be greater than differences within Ss.

The greatest differences between subjects' focal points occur for words which are less common or which have an unusual configurative or both, i.e., phlox, lyre.

Column six in Figure 5 presents the median focal points for the pairs of homonyms. The most interesting pairs is phlox-flocks whose medians are slightly



Raw focal points | Median focal points



Raw focal points | Median focal points

Fig. 3 -- Consolidated results of all focal points for 5 subjects on two separate occasions over words with similar spellings but varying in length. Words are enlarged in the figure.

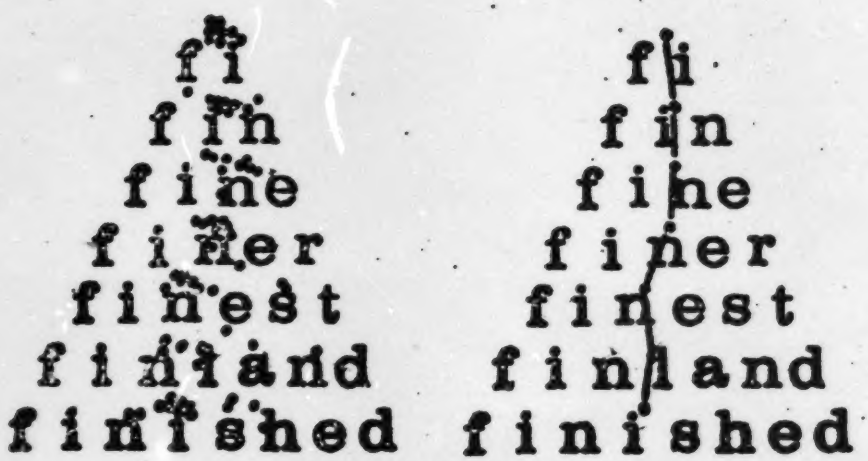


Fig. 4 -- Similar words arranged along a center line. Median focal points are connected. Words are enlarged in the figure.

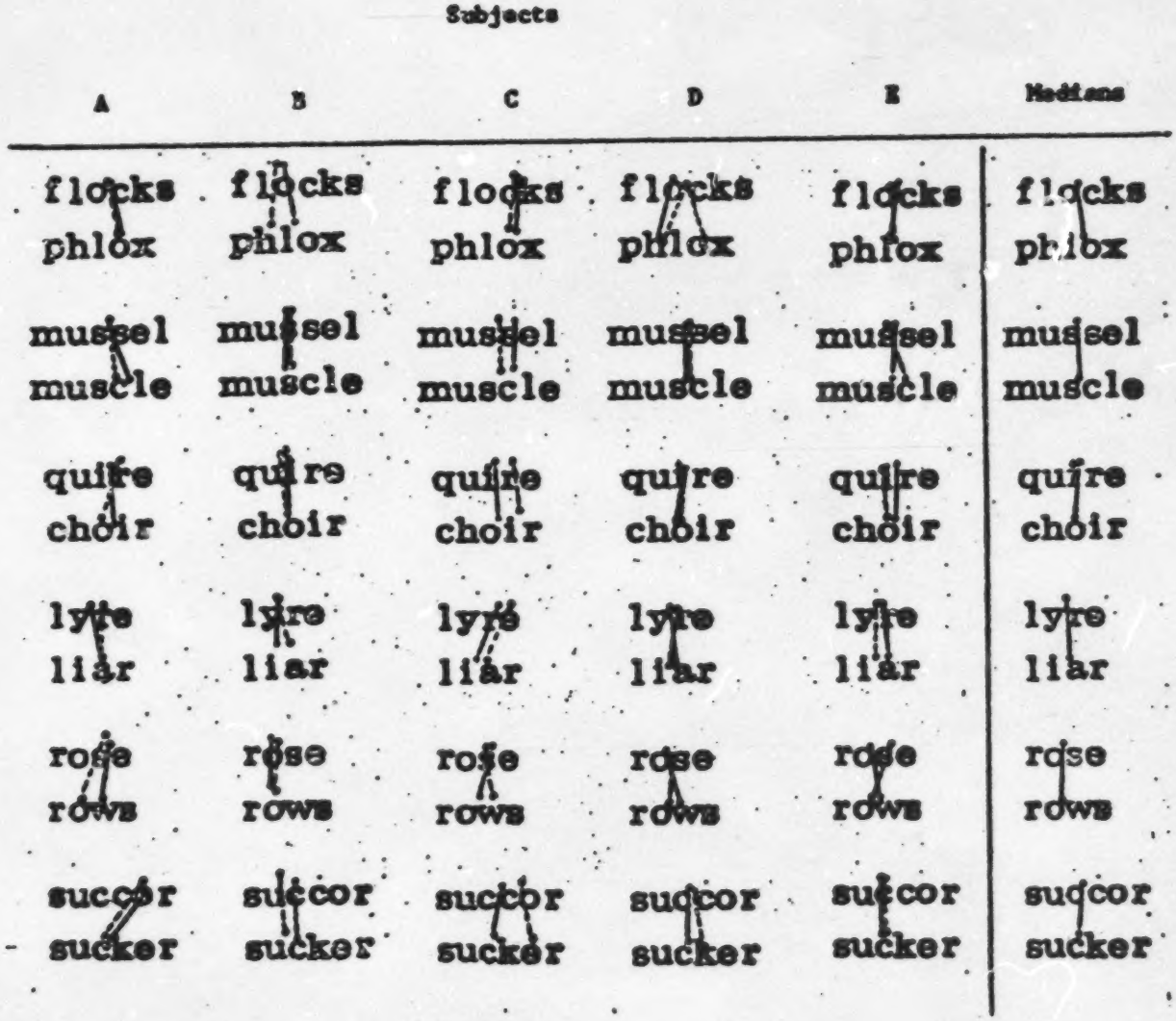


Fig. 5 — Focal points for six pairs of homonyms for each of 5 different subjects on two occasions. Last column contains median focal points over all occasions. Words are enlarged in the figure.

different. Since flocks is one letter larger than phlox one might expect the focal point to fall more to right in flocks than in phlox. The result contradicts this assumption suggesting that the configuration of the word has influenced the fixation point. The pair succor-sucker also shows consistent differences for individuals even though the group medians for each are similar.

Words in Phrases. It was hypothesized that the context of what we read influences our focalization, that is, a strong context and high expectation would determine focal points which were more confirmatory than exploratory. The first studies of this type used three phrases. The dry sahara desert, apple pie for dessert, and the man did desert -- these were formed using 18 point century font press on Letra Set letters and copies made by Xeroxing (See Appendix B). The author and a graduate student responded to random presentations of these phrases by reading the phrase and dotting the last occurring focal point.

Figures 6 and 7 provide enlarged results of this experiment. A clustering of the focal points occurs through a procedure called triangular graphing (Dunn-Rankin, 1975). These figures reveal consistent differences for the three words at the end of the phrases, des-ert, de-sert, and des-sert. It is difficult, however, to ascribe such differences to contextual clues. Since dessert is one letter longer we expect some shift to the right for the focal point on this word. There are slight average differences between des-ert and de-sert which seem related to the differences in the visual and phonetic characteristics of the 1st syllable but no definite conclusions can be drawn.

Figure 6 and 7 about here.

By numbering the order of exposure to the same stimulus, Subject E shows progressive differences in his focal point as he gained familiarity with stimulus and its context. This suggests for him a change from exploratory to confirmatory fixations.

The distinguishing double S characteristic of dessert suggested that such a unique feature might determine focalization. Subsequently a series of 14 sentences containing visually similar word endings (See Appendix C) were presented to five graduate students. The subjects were asked to mark their final focal point in each sentence. Imbedded in this set of sentences were the ending words legion, lesion, and lesson. Each word occurred in at least two sentences.

Figure 8 shows the responses for lesion, legion, and lesson. In this case consistent individual differences are noted but of primary interest is that the focal points are centered over the middle of each word. In this case the three words are differentiated only by their two centrally located letters. Thus context cannot be ruled out as a determiner but the similarity of these results to the responses to isolated words indicates an inability to tell if context is an important determiner of focalization.

Responses to the phrase "The rule or measuring rod for which" were obtained by presenting the phrase 10 times on a sheet of paper and having subjects pinpoint all their focal points for each repetition of the phrase (See Appendix D).

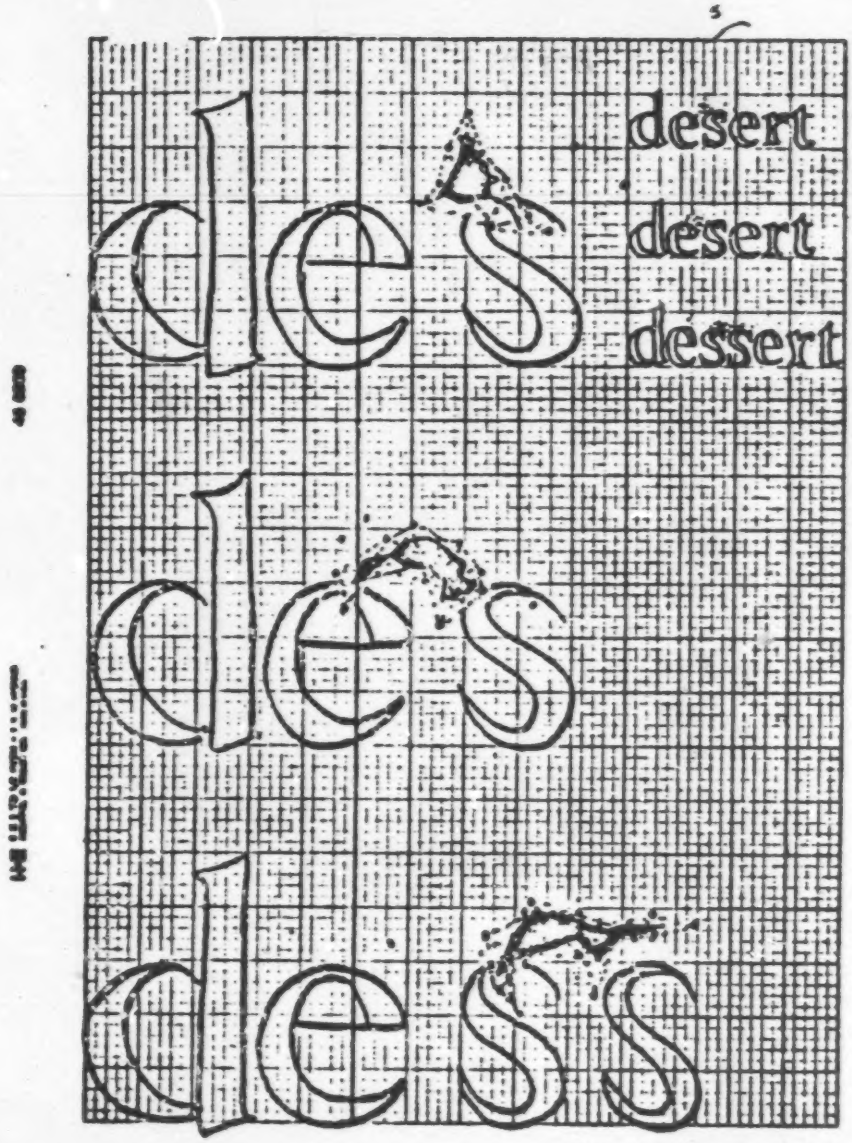


Fig. 6 -- Enlarged results of after image focal points on repeated exposures to desert, desert, and dessert for Subject A.

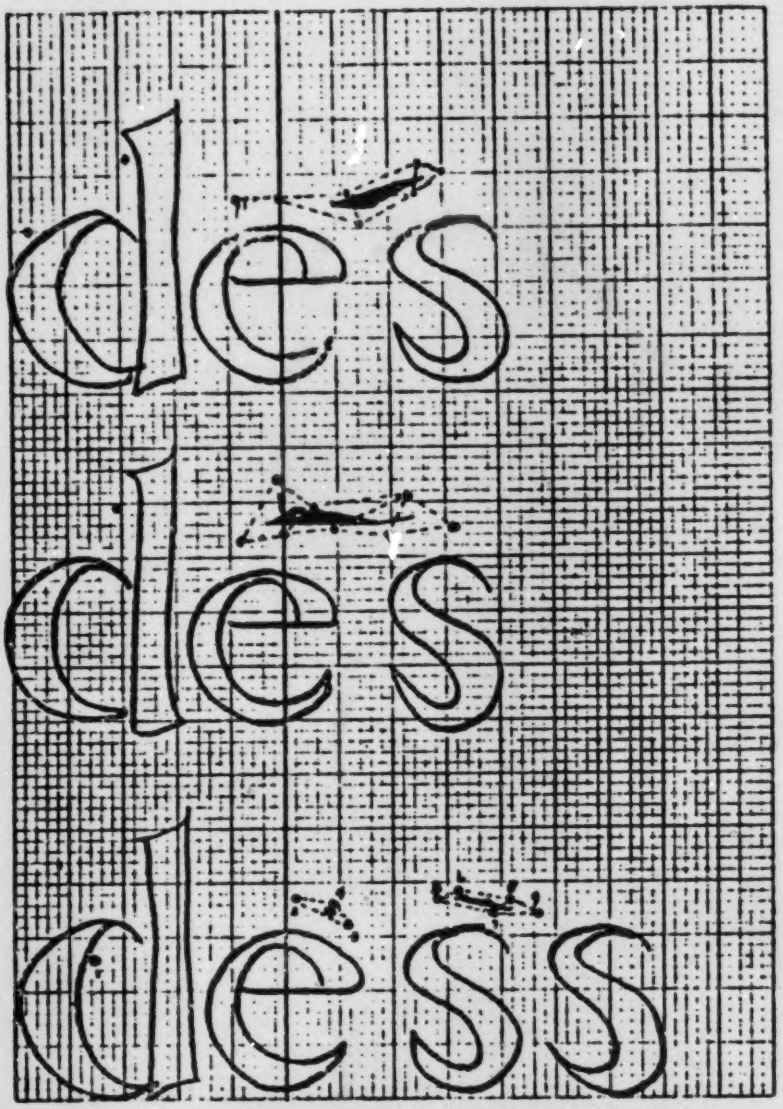


Fig. 7 -- Enlarged result of after image focal points on repeated exposure to desert, desert, and dessert for Subject K.

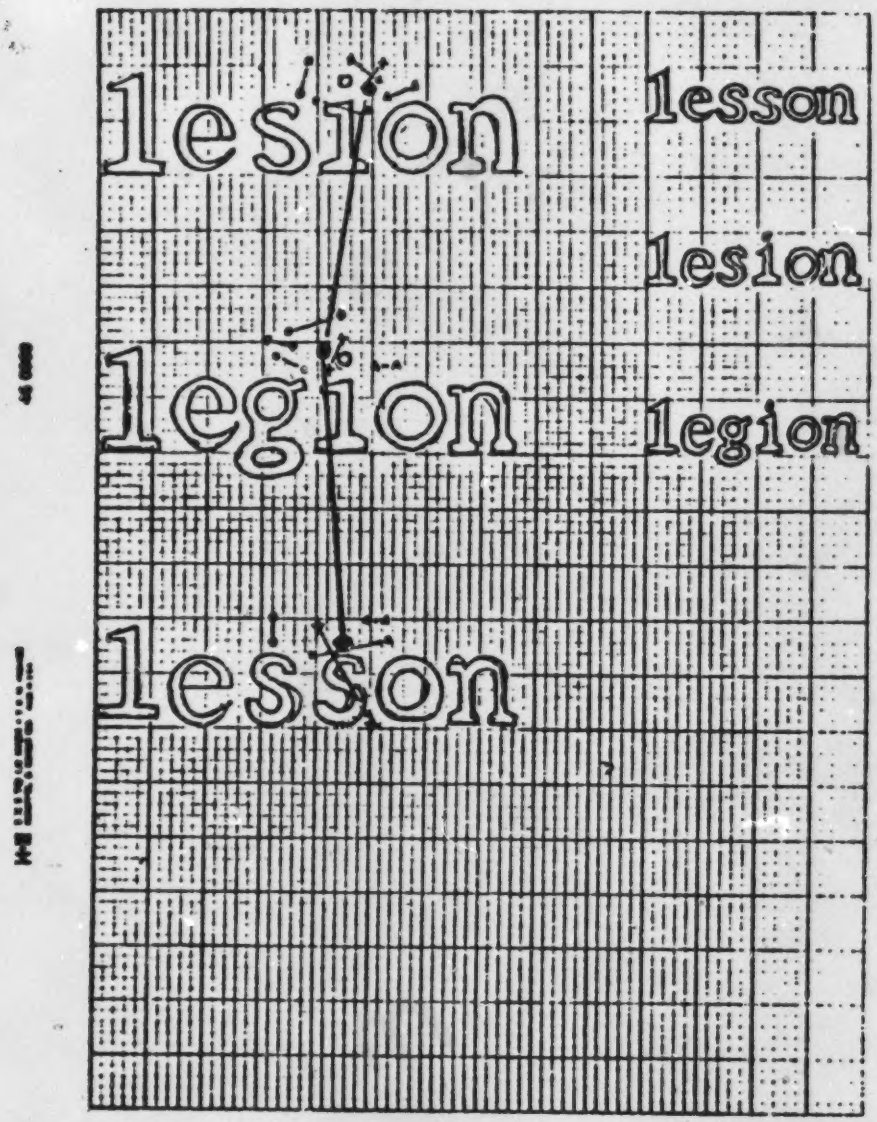


Fig. 8 -- Enlarged result of after image focal points for the words lesion, legion, and lesson. Five subjects responded on two occasions to words found at the end of a sentence.

the rule or measuring rod for which the

the rule or measuring rod for which the

the rule or measuring rod for which the

the rule or measuring rod for which the

the rule or measuring rod for which the

the rule or measuring rod for which the

the rule or measuring rod for which the

Fig. 9 -- Results of 10 exposures of the phrase "The rule or measuring rod for which" to 5 subjects in which all focal points were obtained. A frequency distribution is given at the bottom of the figure.

Figure 9 shows the cumulated focal points for each subject over the ten sets of phrases as well as a frequency distribution for the total number of focal points in each letter space.

Since the average number of "looks" per phrase is 6.5 it is clear that some of the subjects were not reading the phrases in "typical" fashion since 2 to 4 focalizations would normally be expected by mature readers. Despite this artificiality it is interesting to analyze the responses because the cumulative points (1) reveal certain areas of the phrase which are not focused upon and (2) indicate certain letter or letter combinations which are emphasized over others. The u in rule and the o in rod have the highest frequency and one would expect these two points to act as major focal points for the phrase if it were embedded in a longer text and read normally. One can conclude that word beginnings and spaces are not used for focalization. In fact, then subjects were asked to focus on these infrequently used focal positions and asked to read the phrase they were unable to do so or expressed extreme difficulty.

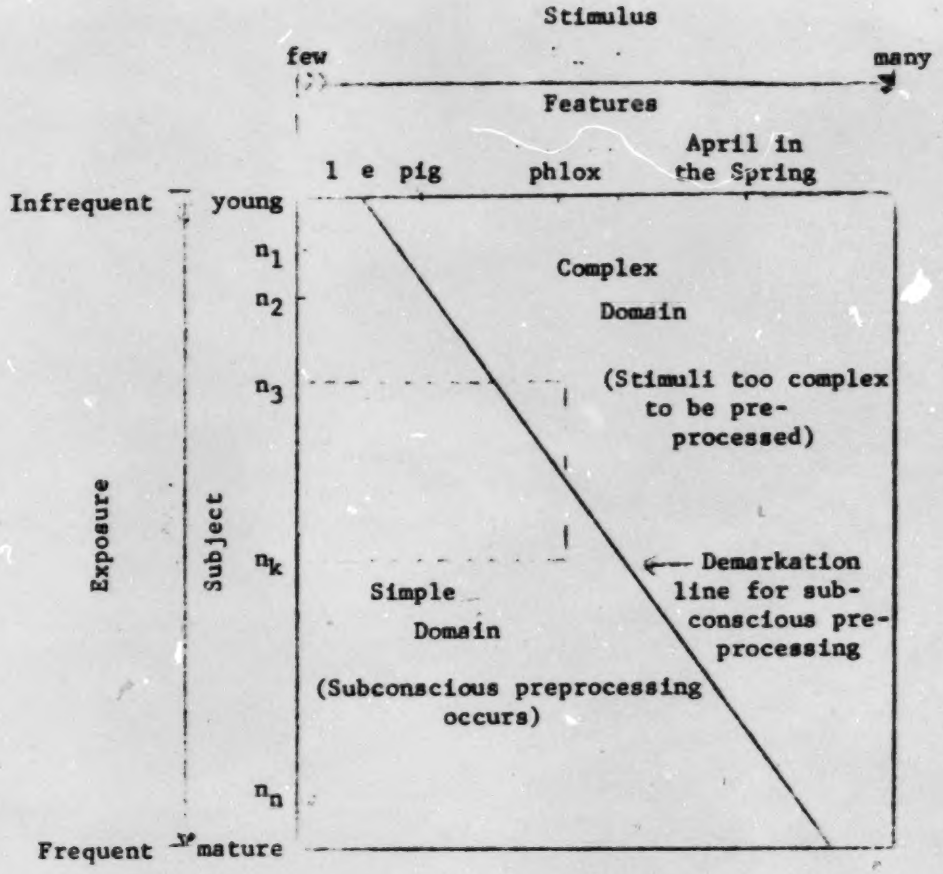
Short phrases, like words, are also viewed centrally. (See Appendix E) The longer the phrase the wider is the dispersion of the focal points. Ascenders in the phrases seem to "catch" the points of fixation. Thus two phrases "so you will" and "as you move" not having any centrally located ascenders appear to create wider dispersions of focalization, much like the word measurement. The last word in the phrase gets little focal attention. In a 3 word phrase beginning words of 4 letters or more are focused upon more than two and three letter words. While focalization is centrally located, most probably based on phrase length, large variance occurs within the central position of the phrase suggesting unique words or letters are partially responsible for a particular focalization point.

All studies suggest peripheral unconscious control of focalization in which the focal points in mature readers are made so that the vision is most efficiently utilized.

Summary and Conclusion

These studies reveal that for stimuli such as words and short phrases the after image can be an accurate estimate of the focal point. The results show that the focal point does not fall haphazardly on the stimulus nor is it evenly distributed. Rather a mechanism of subconscious visual preprocessing is suggested. This preprocessing, while an innate capacity of the organism, is susceptible to development by frequency of exposure to such symbolic stimuli as letters and words. In the mature reader this visual preprocessing results in an efficient placement of the focal point. In the studies reported here almost all focal points were observed on the upper contours of the stimuli centered around and in a sense "attracted by" unique letters, usually internally placed vowels or ascending consonants.

Based on these results and the results of other studies completed by the author a developmental model of visual preprocessing as it relates to reading is proposed (See Fig. 10).



This model states that as a subject increases his exposure to any given stimulus, there is a frequency point at which the stimulus can be preprocessed prior to a conscious awareness. While some stimuli may be quite complex for the immature subject it can be at the level of automation for the experienced reader. Thus fewer and fewer focal points are needed as material becomes increasingly familiar. Familiarity could be formed not only by frequency of exposure to the actual visual stimulus but also because of the content and semantic order in which it is embedded, that is, common phrases could be automatically preprocessed because of context clues or phonetic structure or both in addition to visual familiarity. The model indicates for the young or inexperienced subject most graphic stimuli are complex and must be handled in feature units that are processed through conscious awareness. What is complex for the inexperienced subject may be at the level of preprocessing for the more mature individual.

References

Bouma, H. Visual interference in the parafoveal recognition of initial and final letters of words. Vision Research. 1973. Vol. 13, p. 267-282.

Dunn-Rankin, P. Using triangles psychometrically. Multidimensional Scaling and Related Techniques. U.S.-Japan Seminar, August 20-24, 1975. NSF and Japan Society for Promotion of Science.

Norton, D. and Stark, L. Eye movements and visual perception. Scientific American. June, 1971, Vol. 224, No. 6, pp. 34-43.

Ross, J. The resources of binocular perception. Scientific American. March, 1976, Vol. 234, No. 3, pp. 80-86.

Appendix A

fryer	finland
mean	dormant
dormouse	sweet
tense	means
guide	rose
quire	weather
finished	what
phlox	muscle
watt	fi
lyre	meaner
done	mussel
doing	liar
men	flocks
finest	fine
whether	horde
fin	succor
don	meaningful
friar	me
sucker	tents
suite	guyed
do	recede
heard	finer
choir	meanest
rows	reseed
donuts	

17.

the dry sahara desert

the man did desert

apple pie for dessert

the dry sahara desert

the man did desert

apple pie for dessert

the dry sahara desert

apple pie for dessert

the man did desert

Appendix C

Because he was looking for adventure, he joined the French foreign legion.

After opening his sheet music, John was ready to begin his piano lesson.

He realized that this experience had taught him an important lesson.

Rubbish that is scattered about is often referred to as litter.

Highway signs tell us to put trash into paper bags. They say, "Do not litter."

In the metric system a cubic decimeter is called a liter.

In Europe gasoline is sold by the liter.

He told me many stories, their number was legion.

Because his articulation was poor it was an awkward lesson.

The violin, safely tucked under his arm, the little boy marched off to his first violin lesson.

Look up. See the blue sky.

Put the bacon in the pan. Watch it sizzle. Watch it fry.

The barbed wire cut his leg. It left a painful lesion.

The cut would not heal, it was an open lesion.

The rule or measuring rod for which the

The rule or measuring rod for which the

The rule or measuring rod for which the

The rule or measuring rod for which the

The rule or measuring rod for which the

The rule or measuring rod for which the

The rule or measuring rod for which the

The rule or measuring rod for which the

The rule or measuring rod for which the

The rule or measuring rod for which the

The rule or measuring rod for which the

The rule or measuring rod for which the

the rule or measuring rod for which the

STEPS TO BETTER READING
(Mark which one is same) Appendix E

you may be	you may hear	you may be	you may know
it is not	not as it	it is not	it is not
to mark off	to mark off	to make it	to make of
is to help	is to hurt	is to have	is to help
in this way	in his way	on the way	in this way
as you go	in you go	as you go	on you go
and if so	and of it	and if so	and if so
down the page	down the page	turn the page	down the page
with the eyes	will the eyes	while the eyes	with the eyes
if only for	if only for	if many of	if only for
at the end	at the door	at the end	at the car
and have a	and had a	and love a	and have a
as you read	as you read	as you read	as you need
you will be	you will know	you will be	you will hear
until it is	until he is	until it was	until it is
so you will	so you want	so you will	so you will
as you move	as you move	as you make	as you mind
eyes fixed on	eyes filled up	eyes find out	eyes fixed on
and the rest	and the nest	and the rest	and the rest
of the same	of the same	of the name	of the same